USING STRAIN GAUGE FOR MEASURING OF DIRECT PUNCH FORCE

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Abstract − This article is aimed on presenting our research focusing on force of direct punch. Punches are very important part in a professional defence. Our goal was to measure dependence of force on time. Then we found differences between genders and among groups of participants with different level of training. In this study more than 200 participants took part.

Keywords**:** strain gauge, professional defence, force, direct punch, experiment

1. INTRODUCTION

Physical protection has a very long history and it belongs among basic parts of effective protection of people and property. Human factor is very important for data analysis and for quickly solving some unexpected situation. For these people professional defence training is necessary for effective work.

Professional defence is a field which is primarily focused on the legal protection of personal interests. It covers various areas - theory and practice of defence, attack and prevention, scientific disciplines such as tactics (e.g. skill in the counter attack), strategy (precautionary action) and operation (behaviour after a conflict situation). Moreover, it includes the knowledge of somatology and the chosen parts of crisis management, especially the phases of the conflict and solutions to conflict situations [1].

Direct punch is basic defence technique in majority of martial arts [2], combat sports [3] or combat systems [4]. During direct punch the striking energy (or impulse force) [1] is transferred through arms, particularly through closed fist (Fig. 1). This type of punch is delivered by the arm following a direct line. The aim is to stop the attacker and increase distance between the defender and an attacker. In the following experiment the punch was delivered by the back hand [5].

2. EXPERIMENT

The experiment was conducted by means of strain gauge sensor [6] that was placed into a leather target (punching bag). The punching bag was subsequently attached to the measuring station created from oriented strand boards (Fig. 1) [7].

Fig. 1. Measuring station

The strain gauge sensor of the pressure force, type SRK-3/V (Fig. 2) is a passive electromechanical converter which converts force to a proportional electrical signal [1, 7].

As a mechanical-electrical converter it uses silicon resistive strain gauges because their deformation sensitivity is sixty times higher than that of the film or wire resistive strain gauges. The sensor is sized and calibrated for constant loading of 3 kN force exerted in the axis of the sensor; nevertheless, it also endures a long-term repeated overload up to 200 % (6 kN) in the axis of the sensor [1, 7].
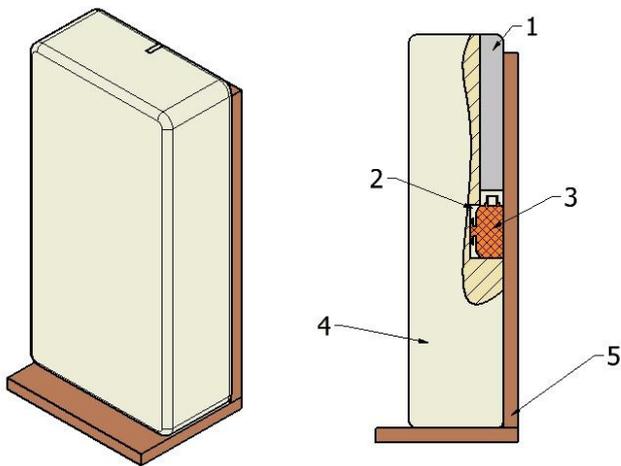
Fig. 2. Strain gauge sensor SRK-3/V in punching bag

1   cavity for cable
2   cavity for strain gauge sensor
3   strain gauge sensor SRK-3/V
4   punching bag
5   punching bag base

The total of 219 participants took part in the experiment; 198 men and 21 women. All participants were in the age from 19 to 25. Based on previous training and experience the participants were divided into following categories:

- Untrained – These people have never done any combat sport, martial art or combat system. They have no theoretical knowledge of the striking technique. The technique was presented to these people before the experiment for safety reasons. Noted further as UTM (for men) and UTW (for women).

- Mid-trained - These people have the theoretical knowledge of striking techniques and do attend the Special physical training course for at least six months. The course is focused on self-defense and professional defense. Noted further as MTM (for men) and MTW (for women).

- Trained – These people have attended the Special physical training course for two or more years or practiced a combat sport or martial art for the same time period. Noted further as TM (for men).

- Self-trained - These people did practice or still do practice (for less than 2 years) some combat sport, martial art or combat system. As there is no guaranty on the quality of the training they are separated into separate category. Noted further as STM (for men) and STW (for women).

During the experiment each person made two strikes. During the measurement the target was positioned in such manner that the center of the strain gauge sensor was in line with the striking person´s shoulder. That way the direct punch has the maximum velocity and force (as there is no decomposition of force or velocity into other axes). The person was made to stay at the same place for the whole experiment. Any unnecessary movement (e. g. lunge etc.) would lead to data distortion [7].

3. RESULTS

For data analysis we used MINITAB - software for statistical analysis. It was possible to find out dependence of the mean force on time, dependence of the maximum force on body's height and mass, dependence of the maximum force on training level and also on gender.

Fig. 3 shows dependence of the mean force on time. There are clear differences among signals due to the training level and the gender.
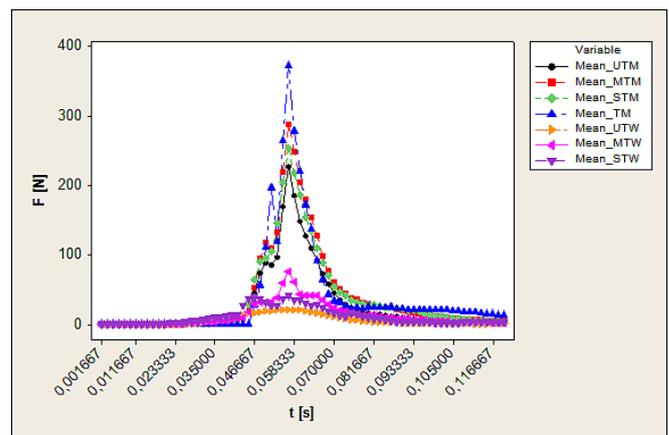

Fig. 3. Dependence of mean force on time

Fig. 4 and 5 shows the dependence of mean force on time, which is divided according to gender. There are differences among training level for each gender.
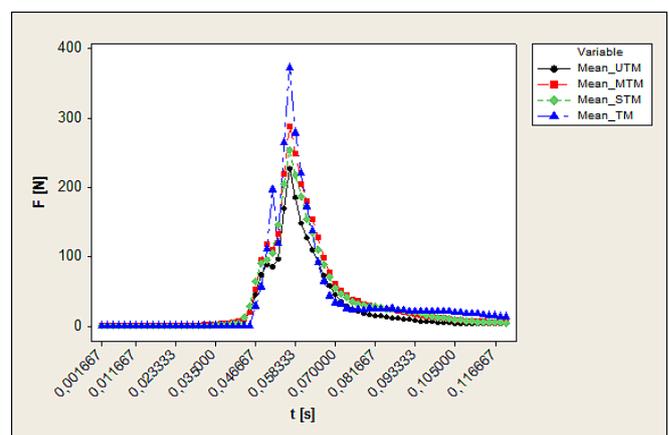

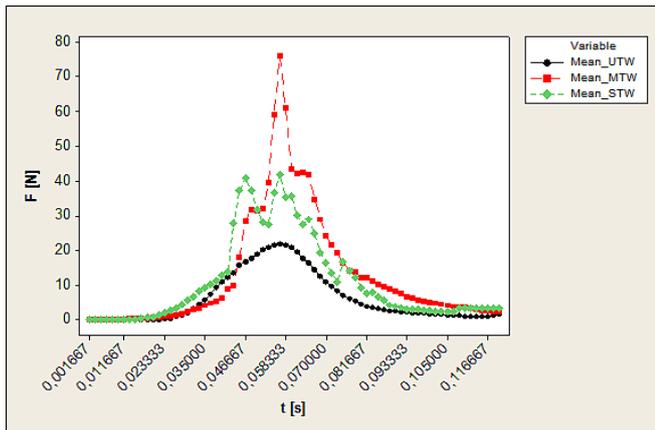Fig. 4. Dependence of mean force on time for men

Fig. 5. Dependence of mean force on time for women

In tables 1 and 2 we can see statistical data analysis. Very important is table 2 with maximum velocity and standard deviation.

Table 1. Results overview for each category

	Mean	StDev of mean	CoefVar
UTM	26,42	52,83	181,74
STM	29,66	61,58	193,65
MTM	33,51	62,5	179,3
TM	36,9	72,2	175,6
UTW	5,078	6,526	127,49
MTW	10,69	17,63	142,26
TW	10,34	13,05	111
	Median	Max	Number of samples
UTM	3,359	228,9	162
STM	4,279	289,5	163
MTM	4,021	254,1	43
TM	13,24	372	4
UTW	2,058	21,75	6
MTW	2,882	75,9	37
TW	3,45	44,6	4

Table 2. Maximum force for each category

	Max	StDev of maximum
UTM	228,9	233,9
STM	289,5	287
MTM	254,1	264,3
TM	372	370
UTW	21,75	7,14
MTW	75,9	103,3
TW	44,6	48,3

Important part of experiment was to find out if it is possible to determine dependence of maximum force on body's height and mass. This is so important because it is expected that tall men with greater weight would have stronger punch than small and thin men.
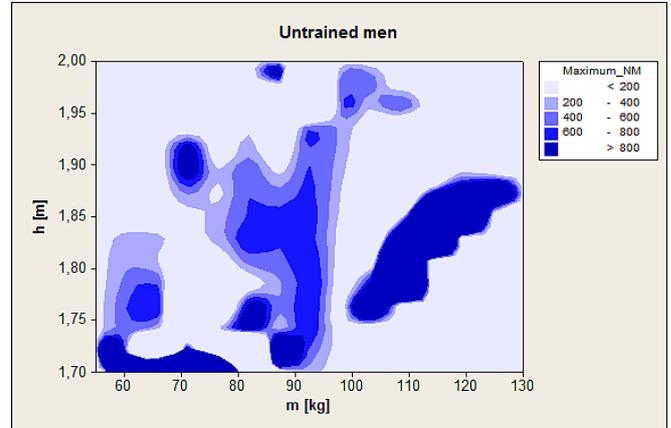

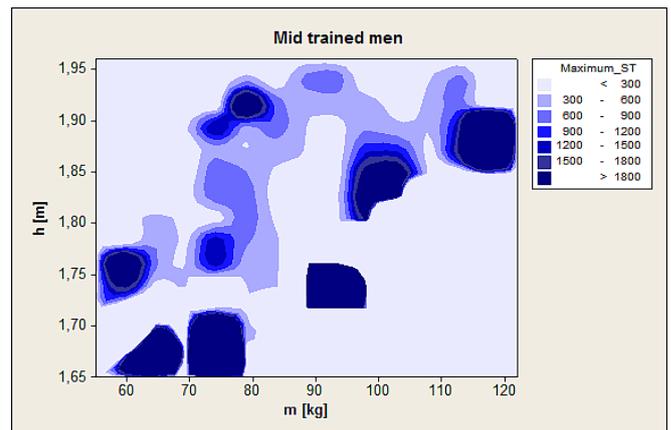Fig. 6. Dependence of maximum force on body's height and mass for untrained men

Fig. 7. Dependence of maximum force on body's height and mass for mid-trained men
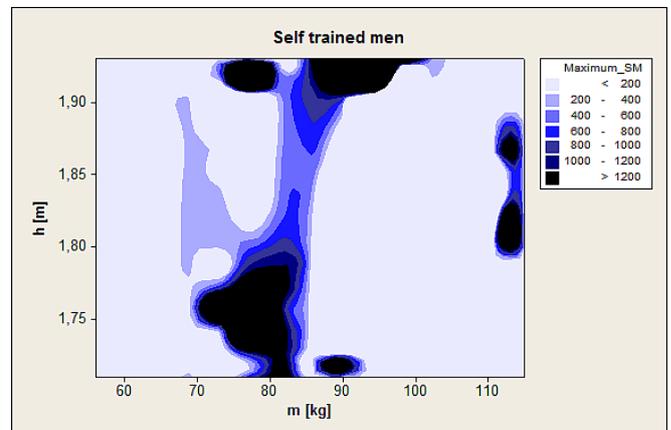

Fig. 8. Dependence of maximum force on body's height and mass for self-trained men
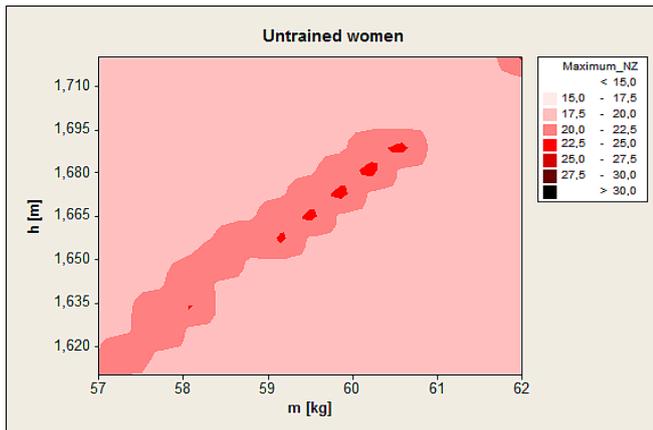
Fig. 9. Dependence of maximum force on body's height and mass for untrained women
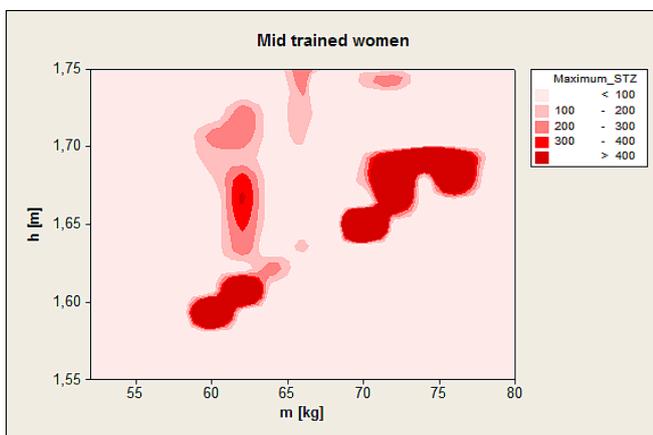

Fig. 10. Dependence of maximum force on body's height and mass for mid-trained women

It can be seen there is not evidential dependence of the maximum velocity on body's height and mass. We cannot say that a higher man is able to have a stronger strike or a more effective strike.

4. CONCLUSIONS

Our experiment was focused on measuring the force of the direct punch. Our goal was to find out a dependence of force on time and a difference between genders. We can state that there are big differences between genders, but there are not evidential and significant differences among groups with different training level.

After evaluating data from strain sensor type SRK-3 / V we have seen that this type is unsuitable for measuring. Due to its size it was problematic to act directly on the center of the sensor, which is required for correct measurement. This problem was shown at moment when there was big difference between two punches for one person.

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